DOCUMENT RESUME

ED 223 507 SO 014 377

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TITLE The Value of Children during Industrialization: Childhood Sex Ratios in Nineteenth Century America.
PUB DATE Sep 82
NOTE 42p.; Paper presented at the Annual Meeting of the American Sociological Association (San Francisco, CA, September, 1982).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Agriculture; Attrition (Research Studies); Census Figures; *Child Labor; Females; *Industrialization; Males; Migration Patterns; *Regional Characteristics; *Sex Differences; Statistical Analysis; United States History; Whites

ABSTRACT

Significant regional differences in the proportion of white male and female children in the 19th century in different areas of the United States may be attributable to the economy. Boys were more numerous than girls in the South and along the frontier, while the ratio was more equal or in favor of girls in the eastern states. Data were obtained from county and state decennial census reports from 1820 to 1860 and were computer-generated into maps and tables which revealed differences in male-female ratios. Of the various theories explaining the causes of these sex differences, it appears that changes in the economic system and in the attitudes of the value of children produced these effects. In an economy of early agricultural modernization, boys were a greater asset to farm families than girls, whereas in industrial urban areas there was little difference in the productive capability of the sexes. Because child labor was widespread during this era, parents could have been influenced to migrate to areas that would be advantageous to the sex of their children and to provide differential care (e.g., boys may have received better medical attention than girls) sufficient to influence childhood mortality patterns. (Author/KC)

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The Value of Children during Industrialization: Childhood Sex Ratios in Nineteenth Century America

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Introduction

Childhood sex ratios in the White population of the 19th century United States exhibited consistently patterned biases, varying regularly by region and over time. Boys were more numerous than girls in the South and along the rolling frontier, while in the Eastern states, particularly in the cities, this skewing was diminished or reversed. (1)

We will argue that the most plausible hypothesis to explain these sex-related differences is the unequal economic value of boys and girls to a household economy typical of early agricultural modernization. Boys were a greater asset to farm families than girls, whereas in many industrial and urban commercial areas the productivity differentials were minimized or reversed by the relative abundance of unskilled labor opportunities for both. We propose that, in an era in which paid and unpaid child labor was still widespread, these sex-linked economic differentials had sufficient force to influence some parents to select a region of residence and an occupation that would take advantage of their mix of boys and girls, or to adopt boys and girls to maximize the productivity of their households, or to provide resources differentially in sufficient degree to influence childhood mortality patterns.

Some general methodological issues are central. One important feature of the analysis is that there is no good way to tell what level of sex ratio in a given region is evidence for or against any hypothesis. We do not know what the "expected" values of the sex ratio should be at early ages. However, we do hypothesize that sex ratios should vary systematically across regional units according to their degree of industrialization.

A second issue is that, since the differences in sex ratios are never very large, we must find ways to estimate the importance of small but persistent differences, tiny biases that are systematically related to underlying cultural patterns. Still another problem is that we can expect no single path of causality. Many patterns of behavior and underlying conditions could have produced the results observed.

Finally there is a problem with the data themselves. While they are abundant, they are not of the highest quality — in some cases the margins of error may be greater than the effects being sought. We assume that such errors should be random, obscuring but not biasing underlying effects. The patterns we observe in the data are so consistent we feel confident that cultural forces were in fact working themselves out in systematic fashion.

We will begin by reviewing the available data and subsequently evaluating the relative likelihood of competing hypotheses that may explain the patterns. Among these we include several that are not connected with the relative value of boys and girls in the household economy. Finally, we review the material relevant to the central hypothesis.

The Data

The basic information for this analysis comes from computerized versions of the published county level tables of the decennial censuses of the United States, distributed by the Interuniversity Consortium for Political and Social Research, University of Michigan. Table 1 summarizes the data by state for the proportion of White children in some age group that are male -- technically the masculinity proportion, hereinafter MP. County level data are used because states are too heterogeneous for fine analysis, although for convenience we sometimes summarize at the state level. County level data are unavailable after 1860.

There are some hints in Table 1 of the analysis to come. Notice that in all of the age groups under 10 the MP either stays the same for succeeding censuses after the first one in which an age group appears, or (more often) declines. There is a trend toward feminization of the age group. This trend is not clearly characteristic of the age group 10-14, which behaves differently. Change in the sex ratio within an age group across censuses suggests that there have been changes in some underlying demographic rates over historical time. In the younger age groups, under 10, in any one census, there is something of a tendency for successively increasing age groups to be more feminine; this is biologically expectable, as we will see, since males die more rapidly than females. However, there is a tendency for the age group 10-14 to become less feminine, especially in 1850 and 1860; this is quite contrary to what one might expect biologically. These differences will fall into a pattern as the analysis proceeds.

There is a troubling statistical issue about these proportions. For example, in 1860 the proportion male under 15 in Nevada was .499, based on 600 children, while that in Rhode Island was .501, based on 55,000. Clearly we trust the latter more than the former, because a random fluctuation in the sex of children recorded (for whatever reason) will have a greater effect in the smaller population. The range of differences observed in the data is around one or two percent. It takes an error in only a half dozen or a dozen cases to make a difference of one or two percent in Nevada in 1860, but an error in 550 or 1100 to make the same percentage difference in Rhode Island. But

we also need to remember that the ordinary kind of sampling theory is not of clear use to us. Except for some undercounting, we do not have statistical samples in these censuses, we have the entire population. Nevertheless, if we think of a census as a result of a sample in time, and the statistical population from which it is drawn as a very large set of such samples, we can see that some of the differences between areas depend on the exact time at which the census was taken. It is not hard to think of a shift of a half dozen children in the population of Nevada from one year to the next. But these theoretical samples over time are not statistically independent of one another at close time intervals, since the same people can be in successive samples (at different ages). Rather than compute statistical indices and probabilities in the initial stage of exploration, we pursue an intuitive appreciation of rather striking patterns in the data and satisfy the need for tests of significance later.

The patterning of the data can first be perceived in a map of the MPs, by state. On each map, for each state, which is the lowest level of territorial organization we can conveniently display, we show the difference between the MP of that state and the unweighted average of all the states in that census. Like Table 1, the maps show the MPs for children under age 15; the first one is for 1800 (Map 1). The map shows a pattern; the lower MPs are in the Northeast (more girls), the higher ones are in the South (more boys). Tennessee, Delaware, and New York do not conform, but the rest do. This same pattern holds reasonably well through 1860, with the Northeast mostly negative, the Ohio Valley and northern Midwest now also negative, and the South and West positive, except for Lousiana and Nevada (Map 2). The large size of urban New Orleans, relative to the rest of Louisiana, may account for its anomalous position in the South, and the data from Nevada are unreliable because of small sample size.

While maps convey pattern better than tabular data, it is inconvenient to look at very many, since a different map is required for every census and for every age group. It would take 33 maps to display the data. Therefore we display only two by way of example, present our intuition of the general pattern, and move to a more condensed display of data. Superficially, the pattern seems to be that there is a relative excess of females in the states first settled, and a relative excess of males in those more recently settled. The differences first appear as a contrast between the New England/Middle Atlantic states and everywhere else, and then this difference follows the rolling frontier, with the female excess gradually moving into one-time frontier regions like the Ohio Valley, but not into the South.

In a general sense, it seems very much as though the excess of females goes along with the presence in a state of

urban settlement and industrial activity, while the excess of males goes along with a preponderance of rural settlement and agriculture, herding, and mining. It would be very interesting to test this association between MP and ecological variables directly for 1800-1860, instead of relying on geography. Unfortunately, there are no consistent, reliable indicators of the balance between these economic characteristics of the states over all the decennial censuses from 1800 to 1860. For the moment we rely on a crude proxy, ordinal distance from Boston. This measure assumes that urbanization and industrialization spread outward over time from the commercial hub of New England. We know that to be false; Louisiana is a case in point, but the measure must serve intially for want of anything else.

Figure 1 shows the MPs in 1800 as bar graphs, one for each age group or sum of age groups (2). In the vertical dimension for each sub-graph, a deficit of males is shown when the bar is below the line, and a deficit of females when the bar is above the line. "Deficit" means less than the unweighted mean of the states; the horizontal line about which the bars are distributed is the level of the unweighted mean of states. The horizontal dimension runs in increasing modern order of distance from Boston. There are sometimes gaps in the horizontal scale because the states did not always come into the Union in the order of their modern distance from Boston (which we use for uniformity across censuses).

In the first graph, we see that states close to Boston had a deficit of males in the ages under 10, while those far away had a surplus of males. On the other hand, in the age group 10-14, the states close to Boston had a surplus of males and those far from it a deficit. The same patterns hold for the early ages through 1860, with ages 10-14 yielding a muddled picture until 1850, when they show a sharp clarity. The pattern of 1850 is repeated in 1860 (Fig. 2). In other words, the suggested pattern of sex bias by distance from Boston is manifest for ages under 10 from 1800 onward, but becomes very sharp for ages 10-14 only in 1850.

Presumptive Causes

These different patterns in the data, by historical year, by age group, and by regional ecological position suggest underlying causes. What are the demographic sources of differences in the MP?

1. Differences in the MP at conception. Information on the MP at conception comes from two sources, extrapolation backward from the MP at birth and sex-specific mortality rates in childhood, and statistics on fetuses aborted very early in

pregnancy. One view suggests that perhaps as much as 2/3 of conceptions are male, but the males die off more rapidly in utero than the females. Another suggests that differences in MP are modest and not affected much by mortality in utero (Teitelbaum 1972; Cavalli-Sforza and Bodmer 1971). The issue is not settled. There is some evidence that the proportion male is increased slightly if fathers are young, and if frequency of intercourse is high, perhaps because of the effects of these conditions and of the XY chromosome combination on the motility of sperm (Cavalli-Sforza and Bodmer op.cit.; Teitelbaum op.cit.. But it is hard to see how these factors would differ geographically or over historical time. Nevertheless, it might be that fathers were generally younger in frontier areas, so that more male babies were conceived there.

2. The MP at birth is the result of the MP at conception and the sex-specific mortality in utero. It is possible that fluctuations in the overall level of mortality in utero might affect the sexes differently, since the males may be more susceptible in utero as they are later. That is, an increase in mortality might take the males first. There is some evidence that highly stressed populations have higher fetal mortality levels and a depressed proportion of male births. However, it is not clear whether urban or rural populations were more stressed in the 19th century (Teitelbaum 1972). The generally higher rates of mortality for large towns, even if concentrated among migrants (Sharlin 1978, 1981) might be evidence for such stress, but there is no direct evidence on rural-urban differences in the sex ratio at birth for the historical period under consideration.

Deliberate fetal mortality through abortion would seem unlikely to yield such an effect, but actually under some circumstances, any effort at birth control might do so. If all women had births unrestrictedly, and if the propensity to have sons were randomly distributed among them with probability p, the MP at birth would be that probability, p. Now, suppose that parity-specific birth control were introduced into the population, so that couples began to limit births after some number. But all might not do this equally. Some which had had only daughters might persist in having children in order to have a son. If these couples had had many daughters only by statistical accident, they would be likely (with probability p) to have a son at any next birth, and their failure to limit births would not change the overall MP. On the other hand, if they had had many daughters because they had a permanent propensity to bear daughters, their persistence would add more daughters to the population than sons, and their behavior would lower the masculinity proportion. There is no good direct evidence on person-specific or couple-specific genetic propensity

to bear children of a particular sex. One can imagine that occurrence of an X-linked lethal recessive that would kill all male fetuses but allow the females to live might produce such a consistent bias. There is indirect statistical evidence for intensification of the probability to bear children of a particular sex, contingent on already having shown that propensity (Ben-Porath and Welch 1980). It is possible that if birth control spread gradually west and south, and was more common in urban areas, that these hypothesized effects might have contributed to the pattern we see in the data (Paul David, personal communication; David and Weir 1981). We cannot discount this explanation, but since deliberate control of fertility was still limited by 1860, the effect cannot have been large.

We now move to more explicitly cultural proximate causes:

3. Post-partum mortality is another potential cause. Infanticide is one version of this, differential care in infancy and childhood another. There is no extensive direct evidence for infanticide in the 19th century U.S., but some of it may well have occurred. If we believed that boys were more favored than girls (a reasonable assumption for the culture), we could explain a general bias, but we would have to explain the geographical differences as well.

There is some scanty direct evidence (mostly literary) for differential care by sex in the 19th century, but the clearest evidence comes from direct mortality figures in Massachusetts around mid-century. Fig. 3 (computed from Vinovskis 1972:211) shows that female mortality exceeded male mortality at ages under 14, and that the differential decreased as size of place increased, finally reversing for towns of over 10,000 population. In the 19th century in general, the mortality of girls was higher than that of boys, a sharp reversal of what modern data lead us to expect biologically. The primary cause of this difference was probably in mortality from tuberculosis and other infectious diseases. Such patterns of differential mortality are well known from 19th century England and Ireland, and from many of the modern LDCs, where they contribute to the same kinds of childhood MPs we see for 19th century America (Johansson 1977, 1981; Johansson, Hammel and Ginsberg 1981; Preston 1976:120-162). The data suggest that the female disadvantage was greater in small communities than in large ones, thus by crude inference greater on average in rural than in urban areas, but the reasons for the urban-rural difference are unexplained.

4. Migration is another possible source of differences. If children moved to different regions at different rates for each sex, or if families moved at different rates

according to the sex ratio among their children, we might find the results we see in the data. But again it must be explained why families with more boys would move to rural areas, and those with more girls would move to cities.

5. Sex-specific under-reporting is another possibility. Obviously, if girls are underreported, their age group will appear more masculine, and vice versa. But again it must be explained why girls would be under-reported in rural areas and boys in urban ones.

6. Age misreporting is another possibility. If all children are reported in censuses, but the ages of the girls are reported as higher, some girls are lost to any age group, and the age group appears more masculine. Conversely, if the boys are reported at falsely higher ages, the group appears more feminine. It is difficult to imagine a general pattern of regionally based age misreporting that would account for the observed differences.

Discussion

A strictly empirical approach offers little basis for choosing between these alternatives. There is, however, a theoretical perspective that can unify our observations.

Some time ago Boserup (1970) noticed that in contemporary developing countries, as the modernization of agriculture proceeded, the productivity of male labor increased while that of female labor remained constant or decreased. It now appears that similar developments in the relative value of males and females occurred in the 19th century United States. David (1980) has calculated that over the first half of the century the value of domestic production on farms remained almost unchanged, while that for the market increased greatly. Domestic production was largely in the hands of women; men were involved in market production. Thus, the relative value of male and female labor altered substantially. If we assume any anticipation of the value of children as adults, or any parallelism between the labor value of children and adults because of sex-segregated labor patterns, then we must conclude that the relative value of sons and daughters changed similarly.

In the industrializing sector of the U.S. economy, concentrated in New England, the relative value of daughters was in fact increased by the proliferation of employment opportunities in manufacturing (Goldin and Sokoloff 1981). Similarly, it has long been known that urbanization offered daughters improved employment opportunities because of the expansion of the urban domestic servant market as well as that in the commercial sector. Preston (1976:147-151) also analyzes sex

differences in mortality rates (which of course can produce sex ratio differences in populations) and briefly discusses potential causes for these differences: socioeconomic discrimination against females, economic modernization altering the conditions of that discrimination, and changes in value systems. Even before agricultural modernization began, the value of males and females in agriculture was unequal. In 17th century England males earned higher rates for the same work than females (Lindert, personal communication). The cultural presumption of unsuitability of agricultural labor for women was transplanted to colonial America, where, among indentured servants, 5 to 10 males were imported for every female (Wells 1975:154).

These comments can be taken as suggestions about the differential value of children to the economic life of families. Child labor was important in all sectors in the 19th century, declining only toward the end. But since child labor was sex specific, its importance could differ for the two sexes in different ecological zones. We propose that the sex-specific value of child labor accounts for much of the patterning shown in the maps and graphs, and that it is consistent with the various demographic mechanisms set forth earlier. The cultural principle underlying these demographic patterns is that male labor is more valuable in agricultural zones, but that that difference declines (or even reverses) in urban zones where industry and commerce provide expanded opportunity for female labor participation. Let us look again at the mechanisms.

1. & 2. The MPs at conception and at birth are unaffected by these cultural values, except that a combination of the introduction of parity specific birth control and a high value on boys might lead families with a propensity to bear daughters to ignore birth control, thereby increasing the number of daughters and lowering the MP. But it is most likely that parity specific control was introduced in areas in which female labor was already more valuable, so that this effect was probably not independently large. Unfortunately, we do not have detailed vital records of sufficient geographical scope to examine this, nor do we have them to investigate the effects of age of spouses or duration of marriages.

3. Post-partum mortality is clearly a candidate for causal agency. If boys were more valuable in rural areas, they would be less likely to suffer infanticide and more likely to receive good care than girls. Conversely, where the economic value of girls approached that of boys, the differences in treatment would be narrowed, or reversed. The role of tuberculosis may be very important here, since it is said to be a disease that responds to careful nursing and improved nutrition, and one that is expensive to treat. Similarly, one might expect

infectious and diarrheal diseases to exhibit mortality biases in response to treatment biases by sex. That differential economic value can affect parental investment in sons and daughters sufficiently to warp mortality patterns has been shown at the household level by Rosenzweig and Shultz (1980) and Chen, Hug and D'Souza (1981).

The kind of mortality data necessary to explore this hypothesis in detail is lacking for most of the United States in the period of transition from an agricultural to an industrial regime. However, Massachusetts kept reasonable records on cause of death by age and sex from 1850 onward. In 1850, only about a generation after the beginnings of industrialization in the state, about 50 percent more females than males of all ages died of tuberculosis. After several decades of development the differential was reduced to 15 percent (Abbott 1897). Teenage girls were most susceptible to this leading cause of death in the 19th century, but their relative disadvantage decreased steadily as industrialization and urbanization proceded. This same pattern is evident in Europe in the century, and much indirect evidence points to the role of nutrition and general care in the degree of resistance exhibited by sons and daughters (Johansson 1980).

This argument claims that improvement in the treatment of females, dependent on their economic value, lowered female mortality rates and thus lowered the MP in childhood. There are, however, some competing hypothesis that deserve consideration.

Mortality rates can change because of changes in the pathogen causing death or the host response to the pathogen, or because particular causes of death decline, or because treatment improves. Any of these factors, if operating sex-specifically, can alter the sex ratios of deaths and thus the sex ratios of survivors. We have claimed that treatment of females improved, so that the MP in childhood declined. A competing hypothesis is that particular causes of death changed their pattern of sex specificity, for example, that tuberculosis and other infectious diseases ceased to discriminate biologically against females, so that males came to take a more equal share of the mortality consequent on those causes of death. There is no evidence at all for such changes in pathogens or host response, in the 19th century or later.

A second possibility is that a particular cause of death, with a record of higher female mortality, declined in general so that over time fewer females were taken and the MP declined. Thus, for example, if tuberculosis consistently killed more female than male children, but it declined in general over the 19th century, the mortality of female children would decline, and

the MP would drop. There is no direct evidence on this point for the 19th century either. However, there are data for the United States from 1900 on, giving mortality by age, sex, and cause of death. These data might be used to establish a trend in mortality in the early 20th century, permitting cautious extrapolation back into the 19th.

If a particular cause of death biased against females declined over time, and if the bias against females remained constant or increased, then one could argue that diminution of the cause would save female lives and thus lower the population MP. On the other hand, if the bias against females for a biased cause of death itself declined as the level of mortality from the cause overall declined, such an argument would be much weaker. Indeed, a decline in the proportion female of lives taken over time would be evidence either for changes in treatment, host, or pathogen.

Preston, Keyfitz and Schoen (1972) provide mortality rates by age, sex, and cause of death for the United States from 1900 onward. The data are not perfect for our purpose, but we procede nevertheless.(3) Table 2 gives the MP of the mortality rates for important causes of death 1900-1950, calculated from Preston, Keyfitz, and Schoen (op.cit.). The data are graphed in Fig. 4 to show the pattern of male disadvantage over time. When the MP in Fig. 4 rises, it means that relatively more males than females are dying, so that any female disadvantage is diminishing. For all causes of death together we note a steady amelioration of the female position, as the MP of the death rates rises, suggesting a decline in the MP of the population. The effect is strong for tuberculosis in the age range 5-14 and weak or equivocal in earlier ages (when, by the way, precision of diagnosis would be less). The amelioration of the female condition is clear in all age ranges for "other infectious diseases". For influenza and bronchitis improvement is shown for females in all but the lowest age range. For diarrheal diseases there is improvement in the lower age ranges and a ragged pattern over age 5.(4)

We see that these major diseases of childhood show a diminution of the bias itself, as the diseases decline. The pattern is particularly clear in the older childhood age ranges, after the initial biological superiority of the females has resulted in the culling of weaker males; it is against these surviving males that the female condition improves. Thus, we are faced with a choice between presumptive change in the biology of the pathogen or host and change in the quality of medical attention between the sexes. We favor the second of these alternatives, there being no evidence for the former and some for the latter.

A parallel check on interpretations can be made for the data from Vinovskis, by size of settlement in 19th century Massachusetts. We must be careful to examine whether the change in relative mortality of boys and girls is a spurious result of a mere worsening of living conditions in larger settlements, culling off males first as general mortality rates rise. Turning again to a graph of Vinovskis' data on expectation of life (Fig. 5), we see that in each constituent age group under 15 the expectation of life fluctuates irregularly from the smallest communities up to those with less than 10,000 population. Only in the largest towns, such as Boston and Salem, does mortality increase (with consequent decline in expectation of life). Intuition suggests that the increase in mortality in these largest towns may have been concentrated among the large numbers of hapless immigrants fleeing Irish economic misery in the 1850's and coming into the larger coastal towns, while the more favorable rates characterized inhabitants of longer residence, living more often in the smaller communities (cf. Sharlin 1978, 1981). As far as one can judge from Vinovskis' original table (which has an open interval at the top), about half of the population of Massachusetts lived in towns with less than 5,000 population, and about three quarters lived in towns under 10,000 population. Thus, one cannot make a clear case that the decrease in female disadvantage shown in Fig. 3 is simply a result of culling males through increased general mortality. We conclude, therefore, that the weight of the evidence suggests the primary operative force in changing patterns of mortality and thus of the sex ratio in childhood to be a shift in quality of care, conditioned on the economic utility of boys and girls.

4. Migration patterns also affect sex ratios in childhood. It is easy to imagine that families with few boys and many girls would hesitate to move to the frontier to carve out a new farm, but that they might well move to a mill town where the girls could find gainful employment, contributing to their dowries and to family income. Such effects have been demonstrated by Matthies in her study of 19th century southern textile towns (1981). Some oblique light is also thrown on this issue by looking at immigrants to the United States landing between 1820 and 1860. There were 5.4 million of them, of whom a million were children, no doubt mostly as part of family units. Children under 5 were .515 male, those 5-9 were .526, and adolescents were .539 male. A large proportion of the immigrant families gave their intended occupation as farming. The masculinity proportion increases with the age of the children, that is, as their labor value became more immediate. Some of this effect may stem from the practice of immigrant men first bringing their sons to this country and only then their daughters.(5) In the highest age group, there may have been some additional effect of the autonomous migration of teenagers. We do

know that children outside of families moved or were sent to regions according to the economic opportunities therein. From the early 1850's onwards the Children's Aid Society and similar charitable organizations sent orphan boys west to the agricultural zones and girls to the mill towns and the cities where domestic employment was possible (Langsam 1964).

5. Differential under-reporting might also affect childhood sex ratios. There is abundant evidence to indicate that socially less important people are forgotten more easily than socially more important people. Anthropologists are familiar with this phenomenon in collecting genealogies and household lists. We cannot ignore the possibility that girls were underreported in rural areas and that the underreporting declined in urban locations, where they were economically more important.

6. Age misreporting is a less obvious cause. Perhaps exact knowledge of age was less in rural areas, and reports of girls' ages were inflated by their more rapid physical maturity. Perhaps marriage might have been earlier for females in rural areas, and very young married girls might have been reported as older because of their social maturity or the physical maturity that might have made them nubile earlier than their age peers, but there is no direct evidence to support the plausibility of these arguments.

A More Direct Test

We now examine some more data to see if they tell us anything about these alternatives. The underlying hypothesis concerns differences between regions, but we do not imagine that climate or other geographical factors are causal; we think they are economic and ecological, combined with a set of cultural values about child labor and other kinds of values pertaining to children and parenthood.

A method to demonstrate this connection in the available data is to relate childhood sex ratios to the level of industrialization at the county level. The 19th century censuses are not very helpful in providing consistent information on the economy. There are data on aggregate values of orchards, livestock, capital invested in manufacturing, and the like, but these differ between censuses. There is some information in 1820, 1840, 1850 and 1860 on numbers of persons employed in occupational categories. Only "manufacturing" is a reasonably consistent category (although in 1840 it is "manufacturing and trade"). Manufacturing was not a simple category in any census, but still, as the proportion of persons actually counted as being "in manufacturing" increased, the economy must have been growing less agricultural, more differentiated.

To what should the number of persons in manufacturing be related to make a proportion? Ideally it should be related to the number of persons at risk of being so employed, but it is hard to know that number. Thus, we take the total population as the denominator of the manufacturing employment rate. For convenience of later statistical interpretation, this fraction is subtracted from 1, obtaining a proportion of people not so employed. The bigger this proportion is, the less industrial and the more extractive is the economy. Given this rate, we can directly examine the relationship between the MP in each reported age group (differing for different censuses) and the non-industrial, extractive character of the economy. Data at the household, decision-making level would be preferable, but they are unavailable.(6)

We can begin this exercise by examining a data plot for the age group 10-14 in 1860 (Fig. 6). Examination is limited to a window on the data, with MPs between .45 and .55 and the non-manufacturing proportion between .65 and 1.0. (Data losses from this exclusion are small and usually involve missing information or obvious data entry errors.) This is a very unsatisfactory plot. Technically, it is unsatisfactory because it is heteroscedastic; that is, the variability in MP is clearly a function of the proportion not in manufacturing. We want to show that the level of MP is so related, but we cannot follow ordinary procedures because of the relation between the variability of the MP and the non-manufacturing proportion. Substantively, the plot is uninformative because the agricultural counties are also the smaller ones. Because they are small, they are likely to have randomly variable MPs, and this is what gives the plot its unacceptable fan shape. To remedy this problem, we use the logit of the points on the abcissa (7). Figure 6, so transformed, is shown as Figure 7.

The general pattern shown in this last figure holds consistently for every age group in each of the four censuses. The results are statistically significant because of the enormous numbers of data points. Some data points are not included. Counties with fewer than 1000 children were discarded uniformly in all censuses to eliminate wildly varying data. (These would be agricultural or badly surveyed counties, or both.) Similarly, outlying observations beyond the data window described were also discarded. Most of those discarded in this step were counties in which it was claimed that no one was in manufacturing; that seems unlikely since occupations like blacksmithing were counted (US 1862:9, 59). Discards outside the window at this second step amount to less than 10 percent. The number of counties is still large, from 629 in 1820 to 1574 for some age groups in 1860.

The strength of the effect of economic base on the MP (b) for all age groups under 10 decreases over time, and the

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tightness of the relationship (r-squared) also decreases.(8) Conversely, the strength of the relationship in the 10-14 age group increases over time, and the tightness of the relationship also increases (Table 3). In any one census, patterns for contrasting age groups are also revealing. In 1820, b is effectively zero for age 10-14, against .0028 for age under 10. This is true in 1840 as well, but reversed in 1850 and 1860. For age groups 5-9 and under 5 across 1840, 1850, 1860, the relationship is similarly stronger for the younger group in 1840 and 1850 but reverses in 1860. Comparing age under 1 and 1-4, the relationship is stronger for the younger group in 1850 and 1860.

These patterns are summarized graphically in Figure 8. Here we see clearly that the importance of the economic base to the MP declines over time for all ages below 10, but increases for ages 10-14. The decline occurs at somewhat different rates. It is slowest in the 5-9 group (declining .0001 in 1840-50, .0003 in 1850-60), next fastest in the 1-4 group (falling .0007 in 1850- 60), and fastest in the under 1 group (falling .0010 in that decade). Thus, the decline in the importance of industrialization to the MP begins and proceeds most rapidly at early ages, more slowly at later ages, but is reversed at the ages closest to actual full employment status.

We also observe from the tabular presentation that the average MP for all counties tends to fall over time for all age groups except 10-14, which tends to increase. Further we observe that in all the censuses, the average MP across all counties tends to drop for increasing age groups, except that by 1850 it increases in the 10-14 age group over its level for earlier groups. 1840 is a kind of crossover point. The richer data in this restricted subset thus confirm the general impression gained from the hints in Table 1, over 1800-1860.

Summary and Ancillary Support

Over the period 1800 to 1860 there is a general downward drift in the MP of children under age 10; there are relatively more females in that age range at the end of the period than at the beginning. For the age group 10-14 the trend is diametrically opposed; the MP increases over time. At any given time the MP is, if at all different, lower in the older age groups than in the younger, except in the very highest age group (10-14), where it gets higher.

These trends are not what we would expect in a stable population (one closed to migration and with unchanging demographic rates) with modern sex-linked mortality differentials. Rather, we would expect to see the MP decline

across the successive ages of any cohort, as the expectable biological differences in mortality expressed themselves in the more rapid elimination of males. In a stable population, we would also see the MP decline across the age groups in any census. But we would not expect to see the MP decline for any particular age group from census to census. That phenomenon suggests that the mortality of males was increasing over time, or that the mortality of females was decreasing, or both. Since we have evidence that there was excess female mortality in childhood, we may suspect that the difference between male and female mortality was narrowing by a lowering of the excess female mortality. The narrowing does not, at this juncture, seem to be an artifact of any general worsening of living conditions, not only because of the evidence of the Massachusetts data by size of community but also because general mortality was stable or falling throughout the century. We might also draw upon other potential causes, such as sex-specific migration or factors affecting the MP at birth. There is no evidence to suggest that an excess of female children progressively immigrated to the United States before 1860 but a preponderance of evidence to the contrary. It remains possible that a continually increasing system of parity specific birth control might have edged the MP downward for every successive birth cohort, but we dismiss this as a major effect for reasons already given.

It seems more likely (although not to the exclusion of all other causes) that changes in the attitude toward the value of children and changes in the economic system combined to produce these effects. At the beginning of the century, the economy was almost entirely rural and based on family subsistence agriculture of an intensive kind. While the labor of all family members was valuable, that of boys was marginally more valuable than that of girls, so that they were better cared for and more easily survived the infectious diseases of the period. As commercial agriculture began to penetrate the farm economy, the value of male labor increased, but primarily at the higher ages. At the same time, the dependence of the family farm on its own male labor was mitigated by the increasing availability of hired labor; families did not have to grow their own workforce. Simultaneously, the economy began to differentiate, providing equalization or marginal advantage to female labor. Finally, the area of settlement expanded and differentiated at the same time, with industrial activity concentrated at first in one region, and extensive agricultural activities like large scale grain farming and cattle ranching appearing at quite distant locations. The productivity of males relative to females in rural areas increased as agriculture was commercialized. Under these later circumstances, families in an agricultural zone but lacking sufficient male labor could hire it, or they could migrate to a zone where male labor was less necessary. Conversely, families

with male labor could move into such zones. Individuals could also move. These additional flexibilities provided new strategies for economic adaptation. The pressure to ensure an appropriate workforce from the beginning of the family cycle slackened, and the differential treatment of boys and girls diminished. Thus we find that the local economic base is less important in the earlier age groups than in the later ones. For any age group except the one closest to maturity, the importance of the local economic base declines over the period analyzed. Conversely, in the highest age group (10-14) the importance of the local economy increases sharply.

The problem of multiplicity of causes is resolved somewhat by this argument. Some causes, like parity specific birth control and infanticide, affect the MP at the youngest age, and the data suggest that these mechanisms probably declined in relative importance, since the MP differentials decrease in the early age groups first and fastest. Differential care affects children at all ages, but the evidence suggests that this was also mitigated over time, probably first for the younger children. Migration as a cause probably increased in importance for the older age groups, either through familial or autonomous migration. The same shifts in cultural attitude toward the value of male and female children might also have affected age misreporting and underreporting in a regular way over time. However, migration, particularly immigration, may have played a major and continuing role in the high MPs over age 10. These multiple causes, then, are neither mutually exclusive nor indiscriminately combinable; each may have played a role for different age groups, differently in different historical periods, and in different regions.(9)

Some confirming evidence comes from another and later data set. Since the decision-making units underlying this process were usually families or persons acting as family members, data at the household level would be preferable. They are first available in useful form as a computerized 1/760 sample of the households of the census of 1900 (from the University of Washington, Seattle). Many of the great processes of economic development underlying the phenomena here discussed had run their course by 1900, child labor was on the wane, and major public health movements had eliminated or reduced many of the common diseases of childhood, whose neglect might select boys or girls for death, as cultural habit dictated. But it is interesting to observe that in 1900, the MP for the White families with head of household an agriculturalist was .508, for non-agriculturalists .505. The difference among native born U.S. Whites actually ran counter to this persistent trend, while that for foreign born Whites showed a difference of .531 to .503, agricultural versus non-agricultural. Migration contingent on familial sex ratios,

or initial immigration of fathers and sons are likely causes, shedding light on the data from earlier in the century. Among all agriculturalists in 1900 the skewing of the MP is stronger for the least rural and weakest for the most rural; proximity to urban locations and thus involvement in market agriculture may have played a role in favoring boys, and families close to urban locations may have been sending their daughters to work in urban domestic service or other occupations, raising the MP for their households and lowering it for households in which the girls resided in the cities. These differences are stronger for the 10-14 age group, weaker for the 5-9 group, and equivocal for the group 0-4. Thus, nothing in the data from 1900 contradicts the explanations put forward for the state level materials 1800-1860 or the county level materials 1820-1860.

Conclusions

Available evidence suggests that migration and adoption contingent on familial sex ratios and differential care leading to sex differences in mortality were shaped by the different value of boys and girls to the domestic economy in 19th century America.

Our review of these data has larger theoretical implications for estimates of the value of children, and the effects of the modernization of agriculture and of the rest of the economy on parental attitudes. The statistical analysis showed that a pattern of behavior indeed exists and that the presumption of economic conditioning of that behavior cannot easily be denied. The arguments may be inverted to infer sex-differential value of children where skewed sex ratios are found associated with cultural rules governing sex-segregated labor patterns. All the arguments are inferential. To show these effects in convincing causal detail requires fine-grained analysis of individual cases; the epidemiological approach must shift to the clinical. Further light can be cast on the relationships by examination of genealogies, family reconstitutions, diaries, wills, local records, and other components of the intimate dustbin of family existence, and it is at this level that analysis should now procede.

NOTES

(1) We are indebted to a number of perceptive commentators, among them Ken Wachter, Ron Lee, Paul David, Richard Sutch, Peter Lindert, and other members of the Stanford-Berkeley Colloquium in Historical Demography and the Graduate Group in Demography at Berkeley, and to the students and faculty in the colloquia of the Departments of Anthropology at U.C. Berkeley and Sonoma State University. We are also indebted to Maurica Anderson for her assistance.

(2) We are indebted to James Baltaxe for the construction of these graphics.

(3) First, they are not restricted to the White population; Black/White mortality differences may upset any analysis here. Second, the attribution of cause of death cannot be reliable in the early years of this century. In particular, it is very doubtful if attribution of cause to respiratory tuberculosis for young children (as opposed to some other infectious pathogen) was more than a guess based on the presence or absence of open tubercular cases among adults in the family. Pulmonary symptoms of tuberculosis are quite rare in children. Similarly, one may doubt the accuracy of distinctions between tuberculosis, "other infectious diseases", and "influenza and bronchitis", or between "other infectious" and "diarrheal" diseases for infants and children. This is only to say that that data are not as good as we would like, and that they are even in the wrong century.

(4) In the higher ages of childhood death from such diseases is rare, particularly by 1950, when only about 1500 such deaths occurred in the entire U.S. for each sex even at age 0, while 6 times that number occurred in 1900. Fewer than 100 such deaths occurred at age 10 for each sex in 1950.

(5) This is almost surely the factor involved in the persistence of biased sex ratios in agricultural zones with large migrant labor populations that can be detected in censuses as late as 1970.

(6) There is a computerized sample of households from the northern states of the 1860 census, drawn by Bateman and Foust, and partially analyzed by Easterlin, Condran and Alter. Unfortunately, the Bateman-Foust sample is one of rural families only. This truncation along the scale of our independent variable makes the sample minimally useful, and no attempt is made to analyze it here.

(7) For those unfamiliar with this transformation, the logit function is $\ln(p/(1-p))$. Where p (the proportion) is 1/2, p/(1-p) is 1, and the logarithm of that is 0. As p approaches 0, the logit approaches negative infinity, and where p is very close to 1, the logit approaches positive infinity. Thus, the logit takes a proportion on [0,1] centered on .5 and maps it onto a distribution centered on 0, running from negative to positive infinity. A good way to think of this visually is to imagine that Figure 6 is plotted on a rubber sheet, loose at the top and bottom but firmly attached to wooden struts at the left and right: both struts can be moved. Two people seize the struts and walk in opposite directions, stretching the rubber sheet. It stretches first close to the struts, so that the points there begin to open up, and the stretching gradually spreads toward the middle as the people move more apart. The sheet is always more stretched toward the ends than it is in the middle (at logit value 0). Figure 7 shows the same data after putting them through the logit stretcher (with a window from .4 to .6 in the MP and 0 to 9 for the logit, that is from a county economy with half the total population employed in manufacturing to one with 2/10 of 1 percent of the total population so employed. The actual data points range from about 30 percent of the total population in manufacturing to about .04 percent. For convenience, Table 3 shows the correspondence between the 10 points of the logit used and the matching proportions employed and not employed in manufacturing. The data as replotted using the logit are much more tractable in regression analysis. No bias is introduced into the data by this maneuver, just tractability to the constraints of linear regression.

(8) For those unfamiliar with the details of this technique, the information from these regressions is to be interpreted as follows: b, the slope of the regression line, indicates the amount of change in the MP induced by a change of 1 unit in the logit of the proportion not in manufacturing. r is the correlation coefficient, and r-squared indicates the proportion of variance in the MP "explained" by knowing the proportion not in manufacturing. For age group 10-14 in 1860 we see that a change of 1 unit on the abcissa yields a change of .0032 in the MP, or about 3/10 of a percent. But it is very hard to think about this relationship, because we have done the logit transformation. Referring to Table 3, we see that at levels of the logit scale around 4, thus in the middle of the scale of the plot, we have a proportion of the population in manufacturing of about 1.8 percent.

A change of 1 on the logit scale averages out in this region to about a 2 percent change in the original proportion, and that induces a shift of about a third of a percent in the MP. Changes in the proportion employed in manufacturing have less effect near logit value 0 and more effect away from it, where smaller changes in the proportion affect the logit more and thus the MP more.

(9) None of them seem to apply to the Black population, slave or free. We can detect no similar pattern of sex bias in it, and this may be because the differential value of male and female labor may have been much less among Blacks (Sanderson n.d.). Black populations have a somewhat higher ratio of female births to begin with, in addition.

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Table 1

Masculinity Proportions by Age Group by Census Year, U.S.

	Age Group						
Year	<1	1-4	<5	5-9	<10	10-14	<15
1800					.513	.514	.513
1810					.513	.511	.513
1820					.513	.509*	.509*
1830			.513	.510	.512	.512	.512
1840			.514	.509	.512	.513	.512
1850	.508	.508	.508	.508	.508	.510	.509
1860	.508	.508	.508	.508	.508	.511	.508

*Data for 1820 seem suspect. The sex ratio is lower in almost all states than in 1810 and lower than in 1830.

Table 2

Logit Correspondences

Logit Value	Proportion not in Mfg.	Proportion in Mfg.
0	.5000	.5000
1	.7311	.2689
2	.8808	.1192
3	.9526	.0474
4	.9820	.0180
5	.9933	.0067
6	.9975	.0025
7	.9991	.0009
8	.9997	.0003
9	.9998	.0002

Note: The proportion is the number of persons reported as employed in manufacturing (or manufacturing and trade in 1840), divided by the total population. See text for discussion.

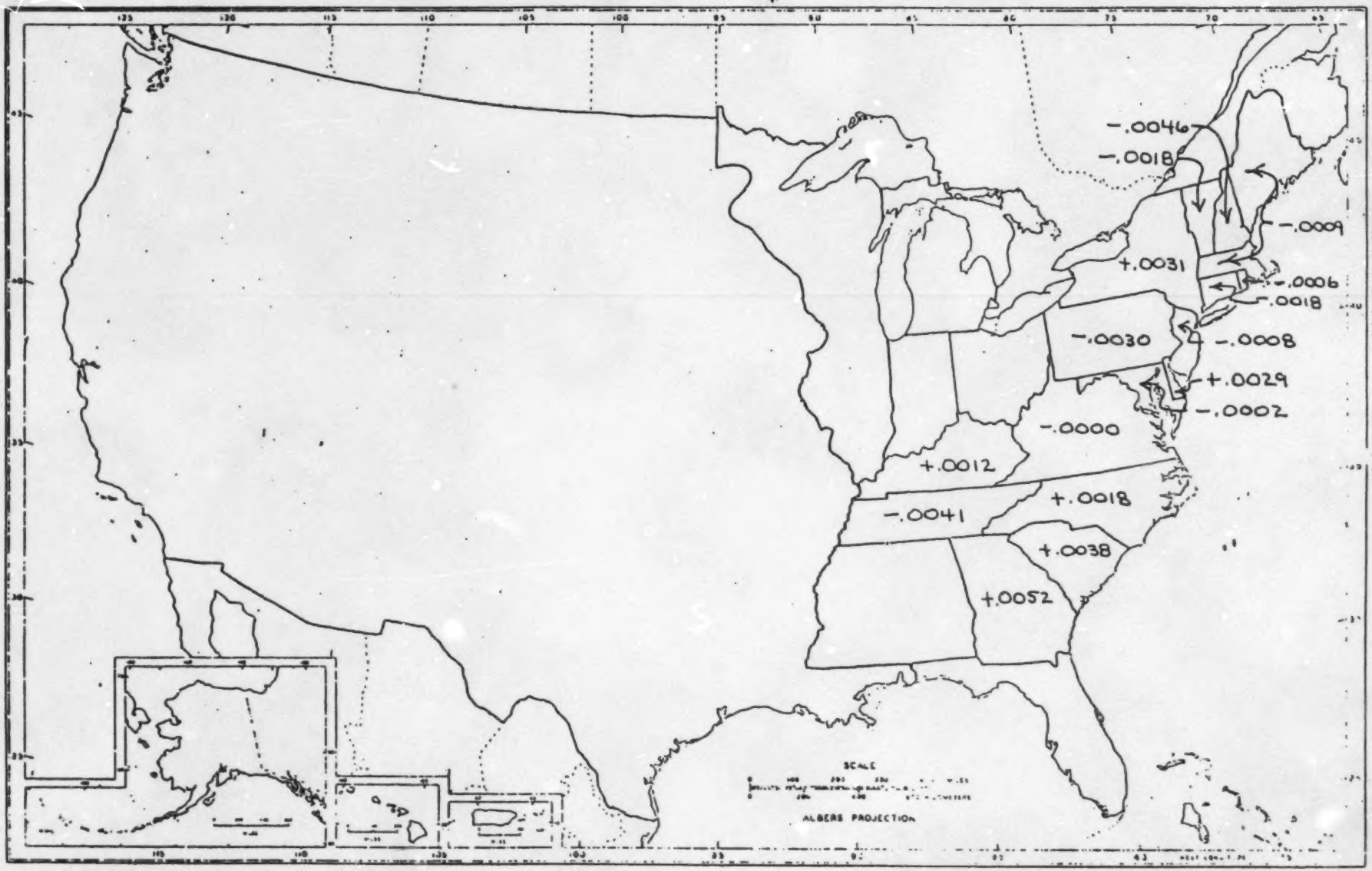
Table 3

Regression Results

Year	Age	N	Logit Mean	Masc. Prop. Mean	A	B	r	r**2	t	Excl.
1820	<10	629	3.91	.514	.504	.0028	.180	.033	4.59	36
	10-14	629	3.91	.505	.506	-.0004	-.019	.000	- .46	36
	<15	629	3.91	.511	.503	.0020	.155	.024	3.93	36
1840	<5	1011	3.77	.515	.506	.0025	.148	.022	4.75	86
	5- 9	1014	3.77	.512	.505	.0019	.103	.011	3.31	83
	<10	1012	3.77	.514	.505	.0022	.162	.026	5.22	85
	10-14	1013	3.77	.515	.511	.0009	.045	.002	1.43	84
	<15	1011	3.77	.514	.507	.0018	.148	.022	4.74	86
1850	<1	1248	4.54	.510	.497	.0029	.101	.010	3.58	120
	1- 4	1270	4.55	.510	.501	.0019	.119	.014	4.27	98
	<5	1270	4.55	.510	.500	.0022	.149	.022	5.37	98
	5- 9	1270	4.55	.509	.501	.0018	.121	.014	4.35	98
	<10	1270	4.55	.510	.501	.0020	.175	.031	6.33	98
	10-14	1270	4.55	.513	.502	.0024	.148	.022	5.34	98
	<15	1270	4.55	.511	.501	.0021	.200	.040	7.25	98
1860	<1	1544	4.36	.508	.500	.0019	.069	.005	2.70	31
	1- 4	1574	4.36	.510	.505	.0012	.076	.006	3.04	1
	<5	1574	4.36	.510	.504	.0013	.090	.008	3.59	1
	5- 9	1574	4.36	.509	.503	.0015	.0.99	.010	3.95	1
	<10	1574	4.36	.510	.503	.0014	.124	.015	4.94	1
	10-14	1574	4.37	.514	.500	.0032	.196	.039	7.93	1
	<15	1574	4.36	.511	.501	.0021	.200	.040	7.25	5

Note: N is the number of counties, less those with less than 1000 children under age 15. Excl is the number of these counties excluded by the data window (see text). Logit Mean is the mean of the logit(1-prop. in mfg.); Masc. Prop. Mean is the mean of the masculinity proportion. A is the intercept, B the slope, r the correlation coefficient, r**2 the coefficient of determination, t the Student t statistic (1.645 is the critical value at the .05 level for the appropriate 1-tailed test).

UNITED STATES 1800 ; Deviation from the unweighted mean $\frac{\sigma^{\prime}}{\sigma^{\prime}+\varphi}$, under 15 No. 10



GOODE BASE MAP SERIES
DEPARTMENT OF GEOGRAPHY
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Map 1

Prepared by Henry M. Leppard
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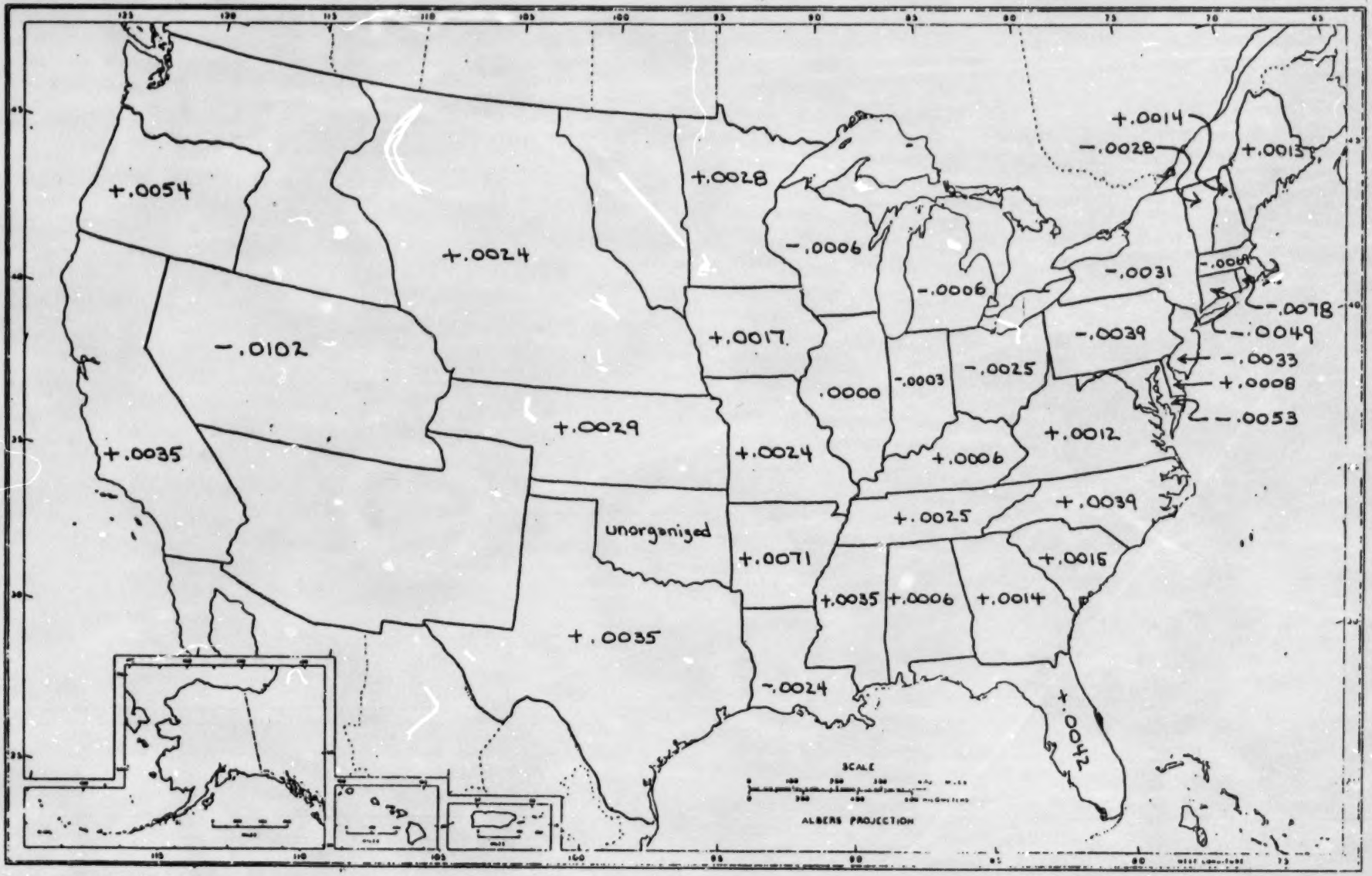
UNITED STATES 1860 Deviation from the unweighted mean $\frac{♂}{♂+♀}$, under 15 No. 10



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Map 2

Prepared by Henry M. Leppard
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DEVIATION FROM UNWEIGHTED MEAN, 1800

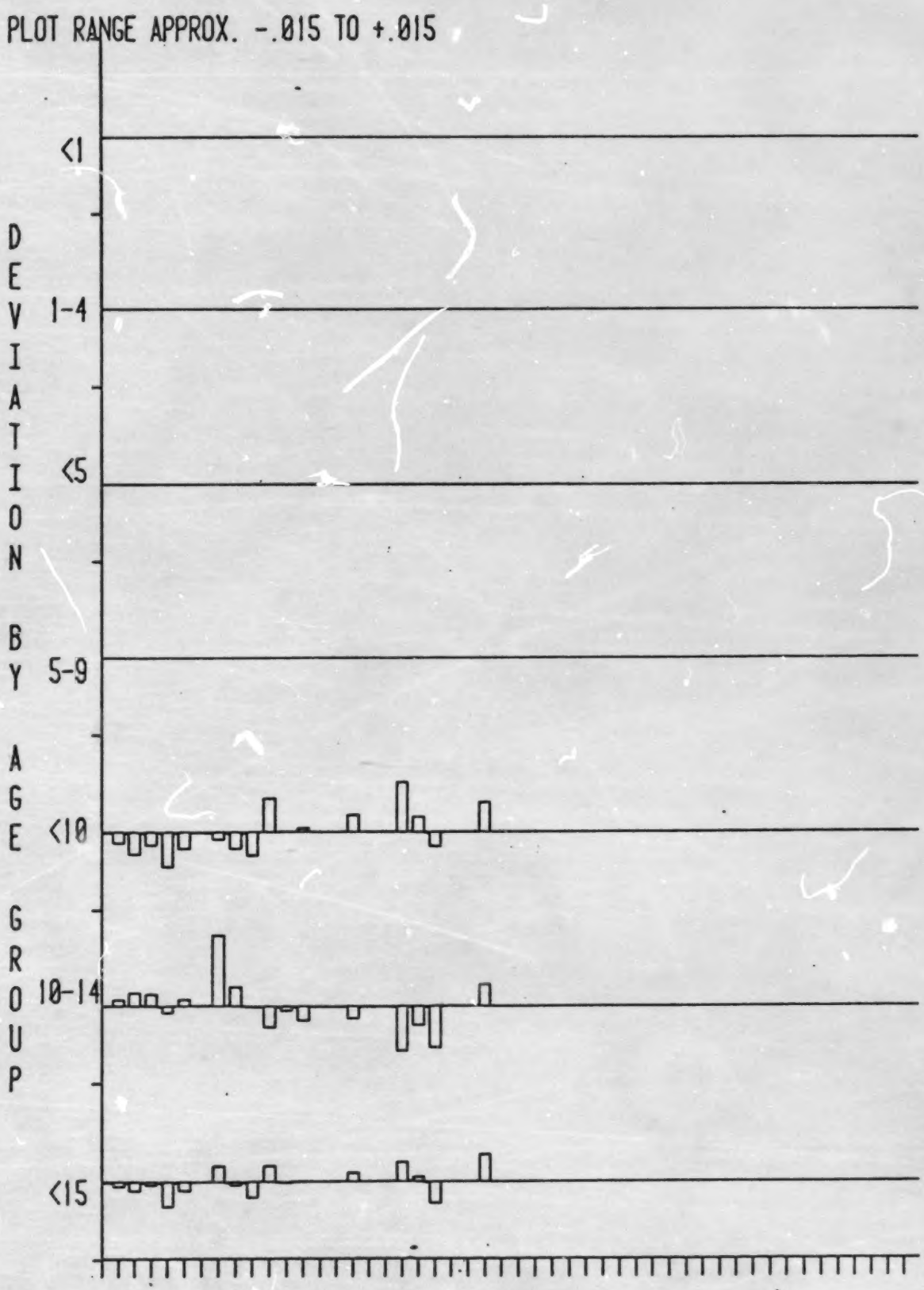


Fig. 1

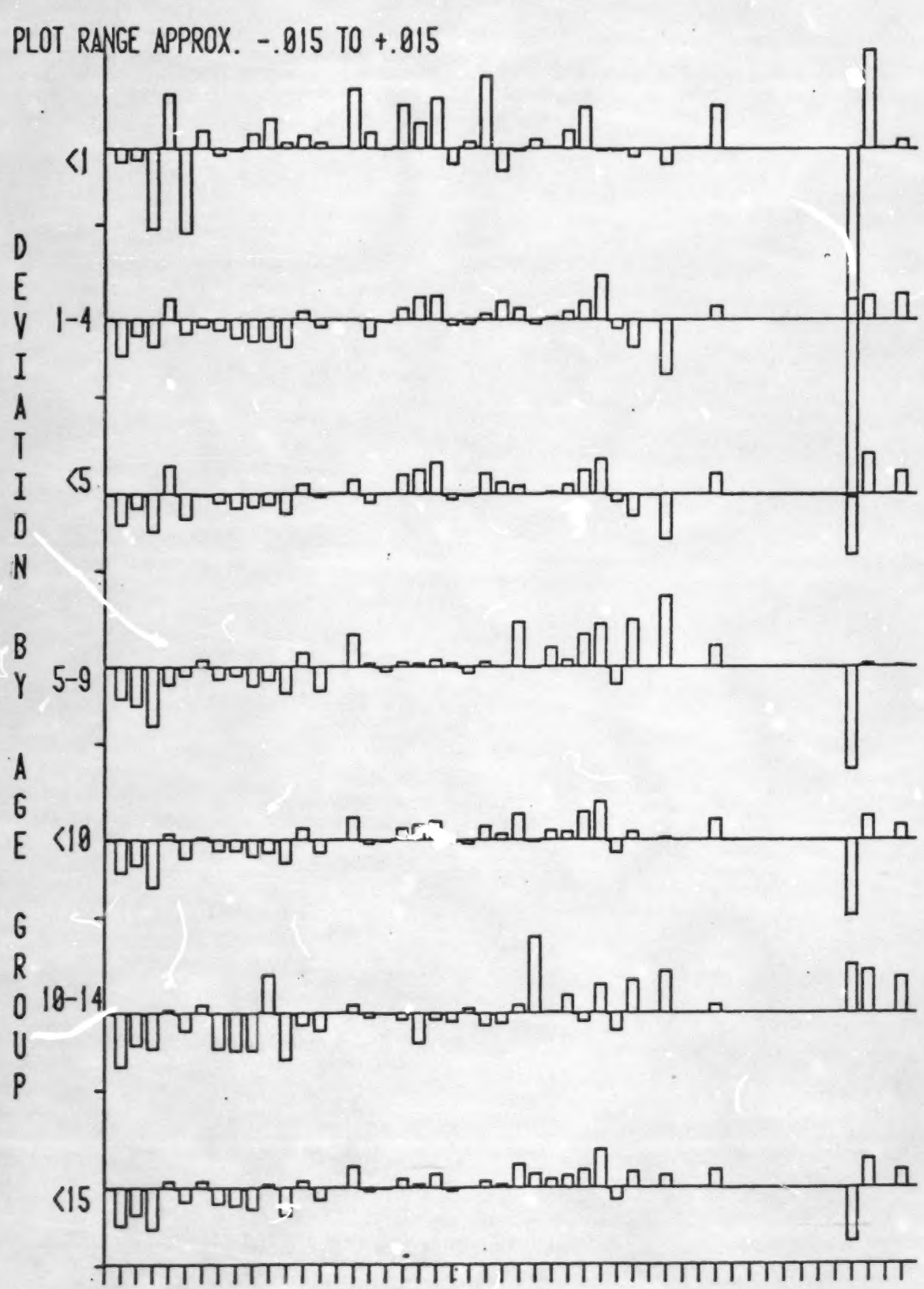
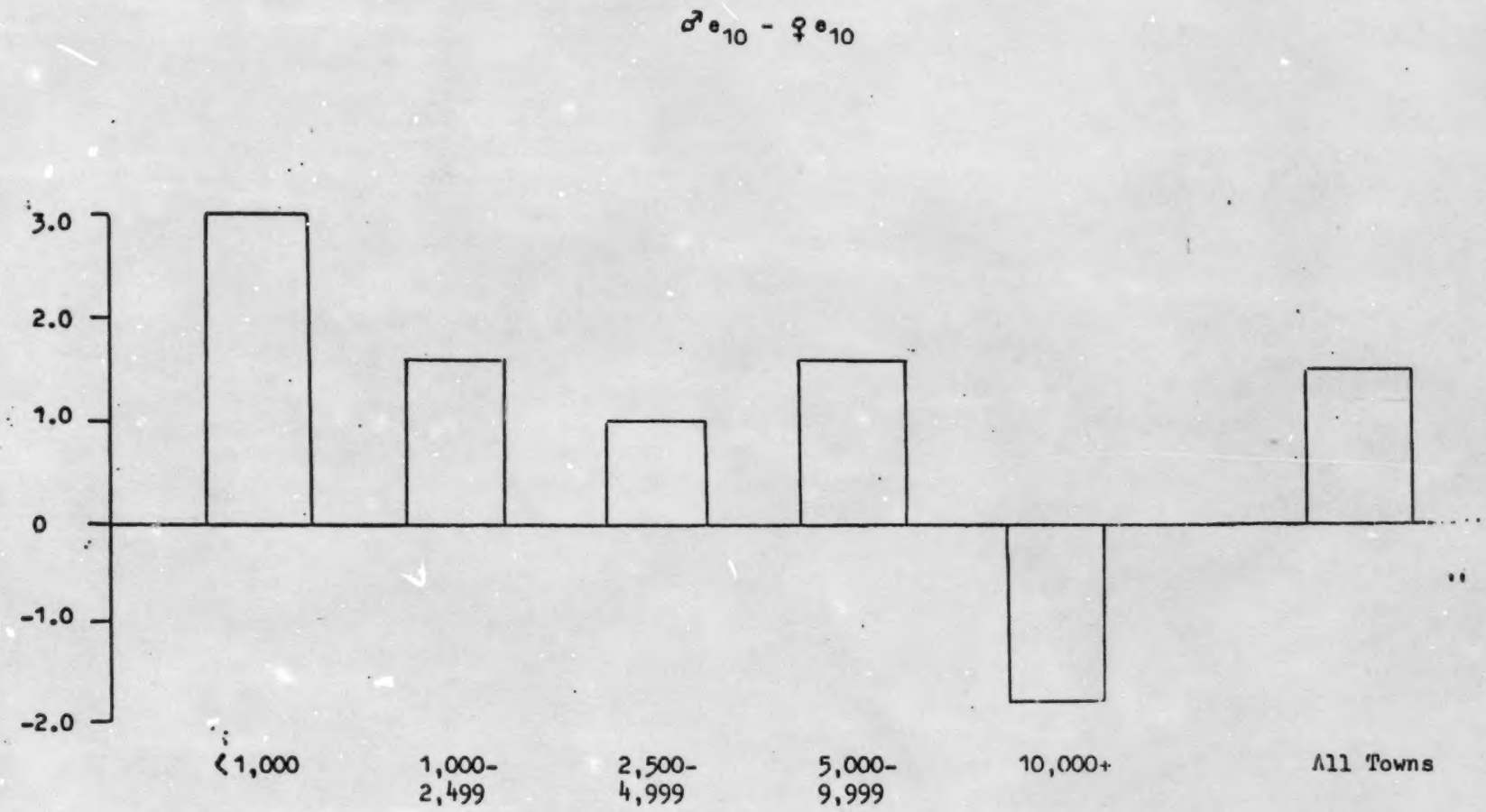

DEVIATION FROM UNWEIGHTED MEAN, 1860
PLOT RANGE APPROX. -.015 TO +.015
DEVIATION BY AGE GROUP
<1
1-4
<5
5-9
<10
10-14
<15
STATE (DB RANK)

Fig. 2

Differences Between Male and Female Expectation of Life at Age 10 by Town Size
Massachusetts 1860



Source: Calculated ffom Vinovskis, 1972, p. 211

Fig. 3

Masculinity proportions of US death rates 1900 - 1950 by cause and age group

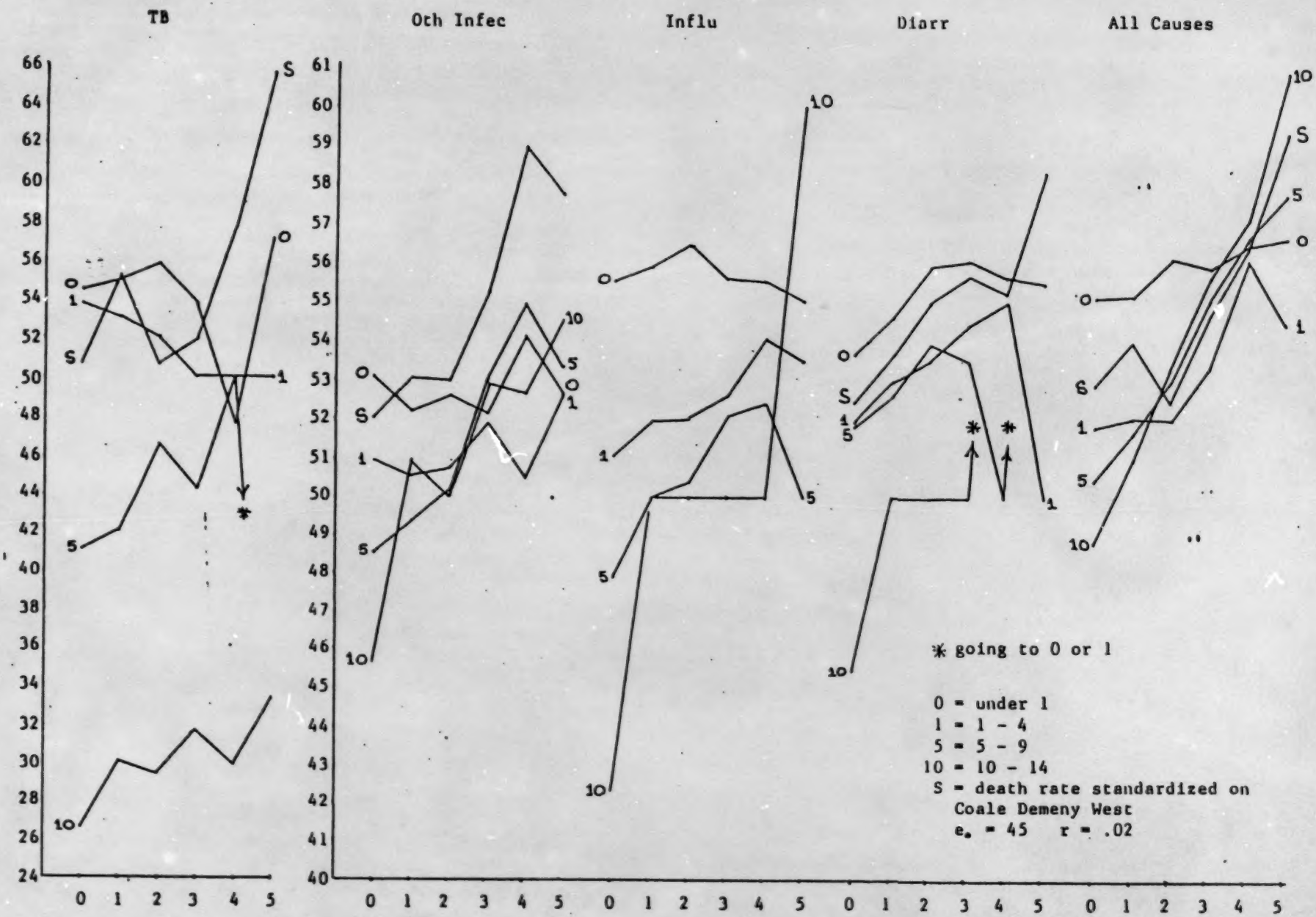


Figure 4

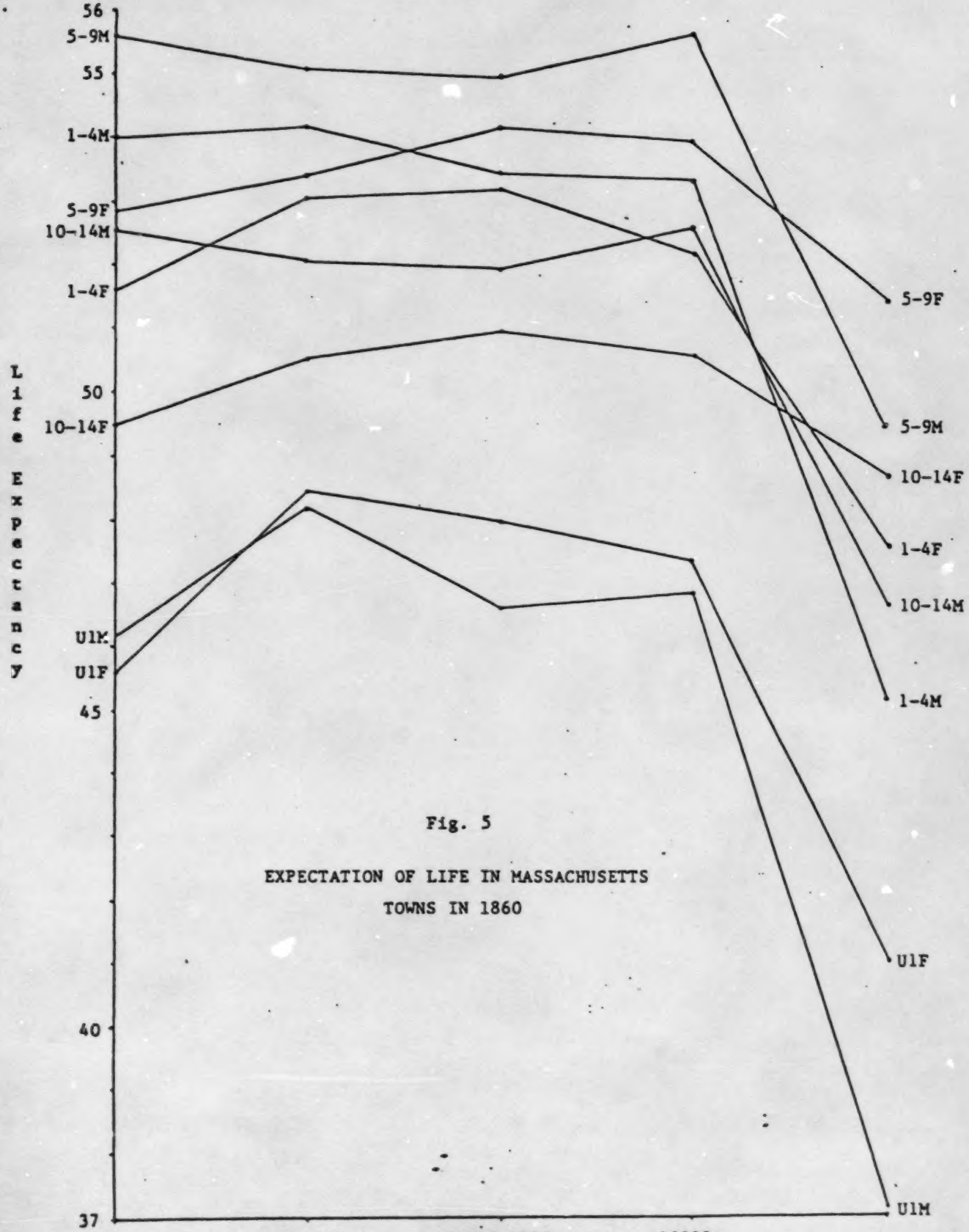


Fig. 5

EXPECTATION OF LIFE IN MASSACHUSETTS TOWNS IN 1860

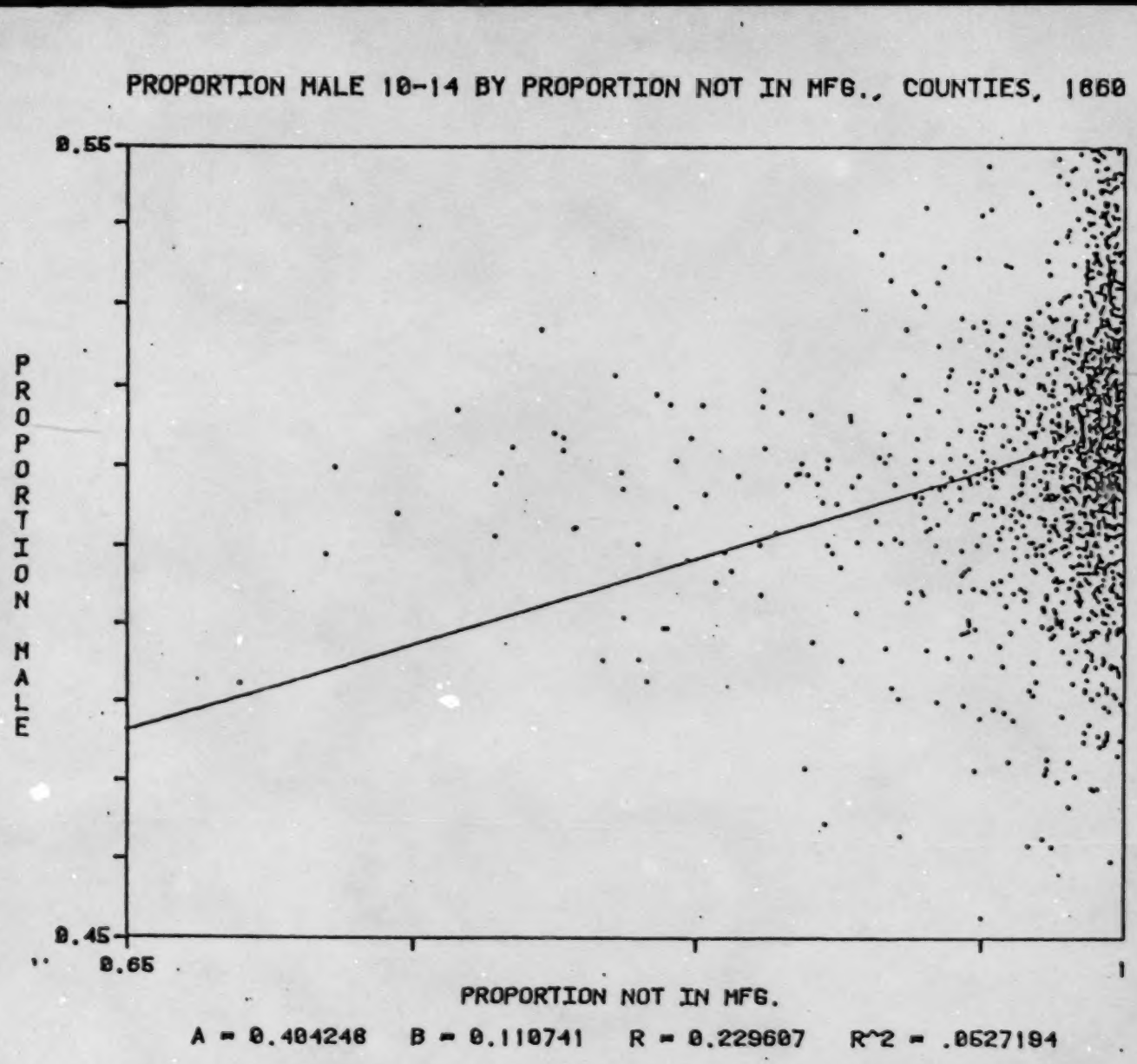

PROPORTION MALE 10-14 BY PROPORTION NOT IN MFG., COUNTIES, 1860
0.55
0.45
PROPORTION MALE
0.65
1
PROPORTION NOT IN MFG.
A = 0.404248 B = 0.110741 R = 0.229607 R^2 = .0527194

Figure 6

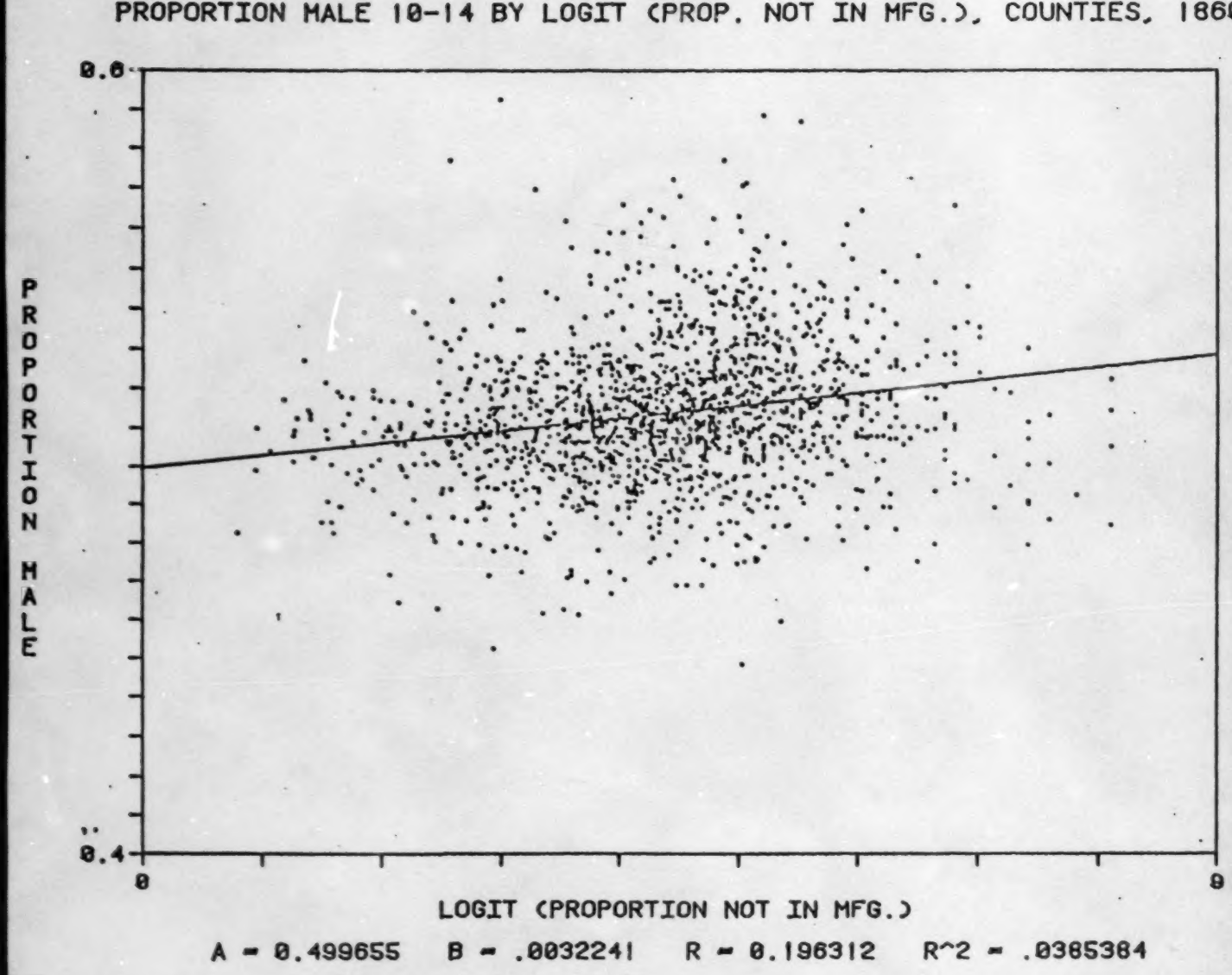
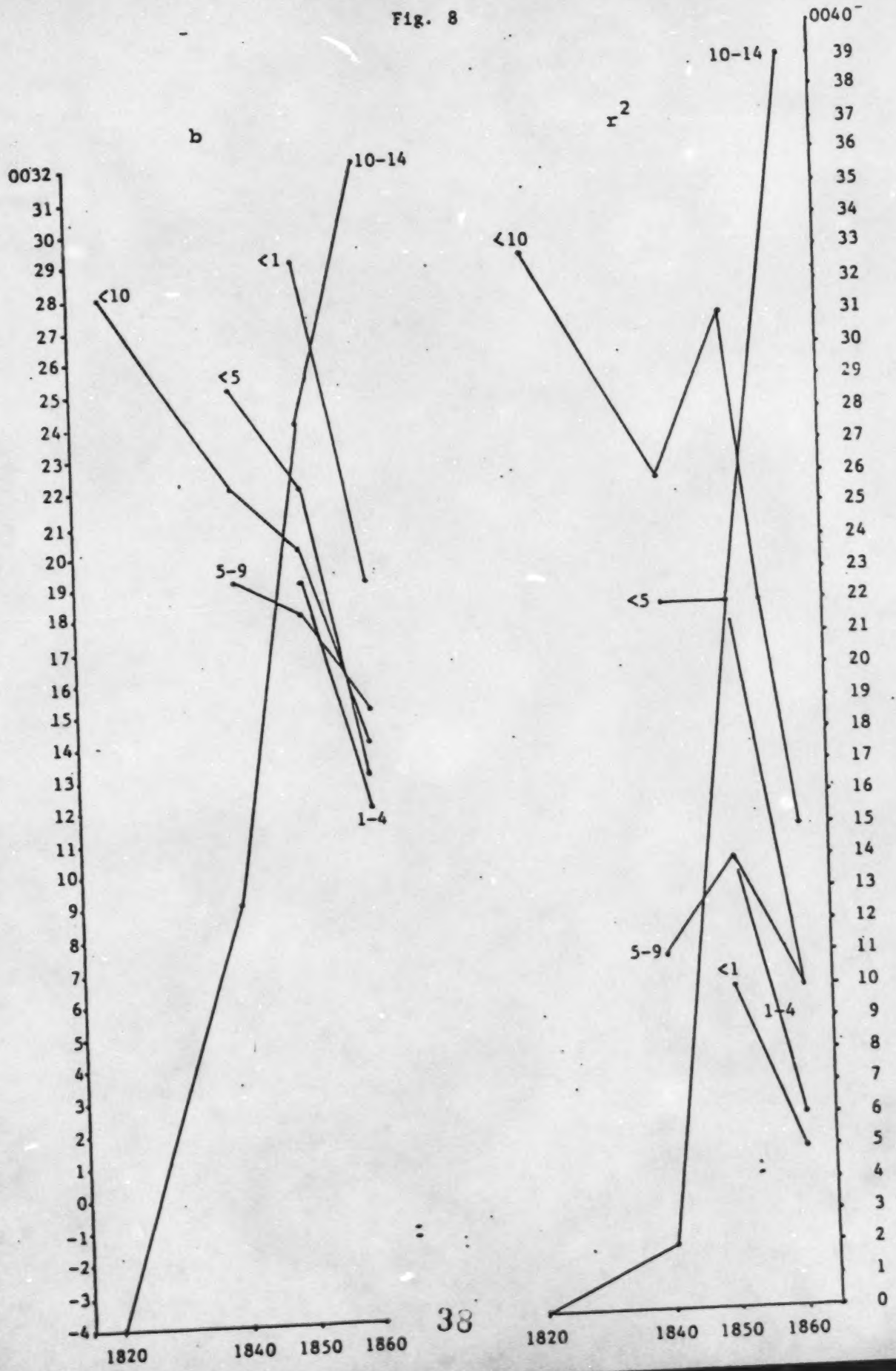

PROPORTION MALE 10-14 BY LOGIT (PROP. NOT IN MFG.), COUNTIES, 1860
0.6
0.4
PROPORTION MALE
0
0
LOGIT (PROPORTION NOT IN MFG.)
A = 0.499655 B = .0032241 R = 0.196312 R^2 = .0385384

Figure 7

Fig. 8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-1
-2
-3
-4
10-14
<1
<10
<5
5-9
1-4
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1840
1850
1860
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4
3
2
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0
10-14
<10
<5
5-9
<1
1-4
1820
1840
1850
1860

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